

The Values of Computational Modelers and Professional Codes of Ethics: Results from a Field Study

Kenneth R. Fleischmann
University of Maryland
kfleisch@umd.edu

William A. Wallace
Rensselaer Polytechnic Institute
wallaw@umd.edu

Justin M. Grimes
University of Maryland
jgrimes2@umd.edu

Abstract

This paper reports results from an analysis of interviews and surveys with computational modelers. The interviews involved asking participants if they felt that modelers should follow a code of ethics. The survey included the Schwartz Value Survey and questions about experiences with and views on codes of ethics. The paper identifies two key themes from the interview data: being faithful to the reality and values of users and that codes of ethics should be developed from the bottom-up. The paper also identifies statistically significant differences between the values of modelers who are aware of and have read existing codes of ethics and who believe that modelers should follow a code of ethics and modelers with contrasting experiences and views, in terms of sixteen basic human values. The study enriches understanding of the complex relationships between codes of ethics and individuals' values.

1. Introduction

Computational models play a fundamental role in science and society today. Because models are embedded in a wide range of products and services, models affect many people beyond their direct users. Models are not value-neutral, but rather are influenced by values that shape the design and use of models as well as values that are embedded within models [4]. Not enough attention has been paid to the role of codes of ethics in computational modeling or other aspects of computing practice [5, 6]. This paper examines the relationship between values and modelers' experiences with and views on professional codes of ethics.

2. Background

Codes of ethics play an important role in the establishment of a profession. Gotterbarn identifies six major functions served by codes of ethics [7, 8]:

- 1) inspiring ethical conduct
- 2) deterring unethical conduct

- 3) educating students
- 4) guiding professionals
- 5) disciplining those who violate the code
- 6) improving a profession's public image

Computing professionals are beginning to understand the need for ethical guidelines for education and practice [10]. For example, the 1992 Association for Computing Machinery (ACM) Code of Ethics was designed as a guide for "socialization or education rather than enforced compliance" [1, p. 98]. Instead of merely listing rules and regulations, the ACM Code of Ethics lays out an ideal relationship between computing professionals and society, as well as computing professionals' obligations toward society.

Similarly, the IEEE Code of Ethics plays an influential role in shaping the computing profession. Martin and Martin highlight the IEEE as demonstrating tremendous leadership in professional ethics [11]. Rosenberg cites the IEEE Code of Ethics as evidence that the IEEE is a responsible professional society [14].

While there has been much theoretical discussion of these and other codes of ethics, there is a need for empirical study of its impact on the practice of computational modeling. Richardson, Hilmer, and Courtney, in one of the few empirical studies of the impact of codes of ethics, designed an experiment to study the influence of authority and proximity on compliance and consequences. They found that authority and proximity do play a role in shaping the consequences that research participants advocate, but that they do not appear to affect compliance. They then call for additional research on compliance with and the impacts of professional codes of ethics [13]. This paper seeks to address the need that they have identified.

This paper poses two key research questions. First, what are the perspectives of computational modelers towards codes of ethics, and what are the rationales that modelers provide for supporting or opposing the notion that modelers should follow a code of ethics? Second, are there any differences between modelers with different experiences with or views on codes of ethics, in terms of their values, and, specifically, which values are positively or negatively correlated with

experiences with or opinions toward codes of ethics? This paper sets out to answer both of these questions.

3. Methods

Field sites for this research included three different organizations where computational modeling featured prominently in research and development activities: a corporate research lab, an academic research lab, and a government research lab. The identities of the participants and of all three sites are confidential following the protocol approved by the researchers' Institutional Review Boards and managers and/or legal staff at all three sites. Because data collection was funded by two separate grants from the National Science Foundation, data collection at the first site took place in 2006 and data collection at the second and third sites took place from 2007-2008.

Data collection for this study included surveys with 76 computational modelers and semi-structured, open-ended interviews with 40 of those modelers. Data collection also included focus groups at the beginning and end of data collection at each of the three sites. This paper focuses primarily on a subset of the survey results that focus specifically on experiences with and views on codes of ethics, with additional insights provided through some of the interview responses.

The Web-based survey administered to all 76 modelers included the Schwartz Value Survey [15], demographic questions, and questions about the role of values in computational modeling, the modelers' ethics education backgrounds, and the modelers' experiences with and perspectives on professional codes of ethics. Specifically, modelers were asked: "Are you aware of the code of ethics of any professional organization?" "Have you ever read the code of ethics of any professional organization?" and "Do you feel that computational modelers should follow a code of ethics?" This paper focuses specifically on correlating the answers to the questions about codes of ethics and the results from the Schwartz Value Survey.

Interview questions were then tailored according to participants' answers on the survey. For example, participants who answered yes to the last survey question were asked: "Please explain why you think computational modelers should follow a code of ethics," while participants who answered no to the last survey question were asked, "Why don't you think that modelers should follow a code of ethics?"

To determine the relationship between the weighted Schwartz values of the modelers and their responses to the code of ethics questions, a statistical analysis was conducted using the Mann-Whitney U test. The Mann-Whitney U test is used to compare two separate

distributions. It is the non-parametric equivalent of the independent samples t-test. Given the ordinal nature of the sampled data (i.e., Schwartz values which are rated on a scale from -1 to 7, and it is not safe to assume that the distance between 3 and 4 is the same as the distance between -1 and 0), this non-parametric test was determined to be the most appropriate statistical choice, since it is far more robust and carries fewer assumptions as compared to similar parametric tests. Because of the robustness of Mann-Whitney U, false negative results are far more likely than false positive results – that is, while the relationships that are established through this data are quite robust and compelling, and would likely continue to hold as the sample size is increased, a larger sample size might also yield additional statistically significant findings.

To analyze the data, modelers were grouped into two categories based on their responses for each yes or no question. Using the question as the grouping variable, all 56 Schwartz values were then individually selected and used as the test variable. The total sample size of respondents was 76. Schwartz values responses were on an ordinal scale ranging from 7 to -1 (see Table 1). SPSS software was used to perform all of the statistical analyses.

Table 1. Scale of Schwartz Value Survey [15]

How important are each of the following values as a guiding principle in your life?	
Numerical Score	Meaning
7	Of supreme importance
6	Very important
5	...
4	...
3	Important
2	...
1	...
0	Not important
-1	Opposed to my values

4. Results

This section details results from both the interviews and the surveys conducted at all three field sites. First, the interview results provide insights about the general perspectives of modelers toward codes of ethics. Next, the survey results provide details about the values that are correlated with specific experiences with and opinions about codes of ethics. Overall, the triangulation of methods provided in this paper allow for a detailed and in-depth understanding the relationship between modelers' experiences with and views on codes of ethics and their values.

4.1. Interview Results

The interview results provide background information about the perspectives of computational modelers on codes of ethics. For example, one participant explained that computational modelers should follow a code of ethics, because otherwise they might try “cooking the books.” Another modeler explains:

I think...it will lead to better results, actually. If you follow a code of ethics, it means you're doing the best for yourself, for other people, and you're creating a model that's as true to reality as it can be, with the data that you have.

The issue of models substituting for reality and the need for that reality to be faithfully depicted was a recurring theme in our interviews. For example, another modeler, asked whether modelers should follow a code of ethics, remarks:

Yes I do. I think that if you're going to do...modeling, and if your goal is for it to substitute for experimental data, then you need to be aware of what you're replacing. Just for your own knowledge, it's important to know what goes into that study. You need to be aware of...ethical responsibilities.

Similarly, another modeler comments:

Everyone needs to assume that a model gives you a good answer. A coder that does something just for money, that looks bad for the whole modeling community. Having a code of ethics means that you're not just going to type code, you're going to evaluate it.

Here, it seems that not only do models need to be accurate; they also need to match the values of users. Another modeler agrees:

If we're going to produce models, they need to be accurate and they need to be useful. I don't want to lead people along the wrong path...They need to be grounded in a code of ethics. I think it's essential.

Finally, a modeler makes a strong statement about the need for codes of ethics not only for modeling but also for other professions as well, “I think everyone should follow a code of ethics, not just computational modelers.” Thus, many computational modelers have strong opinions about the need for codes of ethics, and make compelling arguments in their defense.

Support for following a code of ethics was far from unanimous among our participants. For example, one participant explains, “I think ethics is internally

motivated, it strikes me that a professional code would have little effect.” Similarly, another participant elaborates,

Codes are not legally enforceable. People who might have a lower level of ethics unless they were threatened with punishment might not follow the code. I guess it's useful as a direction if you want to follow that. But there will be a lot of people who won't take notice of that.

A third participant agrees, “It's good to have something to look at, but I'm not sure signing up to a code of ethics is going to sway a person in what they're going to do.” These modelers all seem to agree that a code of ethics that would be followed and enforced would be a positive step, however, they feel that this is not possible. Thus, it is not the need for modelers to follow a code of ethics that they disagree with, but rather the feasibility of universal acceptance and enforcement. Finally, yet another participant makes the boldest case for opposing the use of codes of ethics in modeling:

I don't know that you could give me a code of ethics that would be relevant. I don't see where the twain meets. Assuming that your motivation is to do the best science possible. That's implicit in my job of being a good modeler.

Upon further inspection, however, it appears that even this participant still argues that modelers should act in an ethical manner, however this participant argues that this is implicit in being a good modeler. Thus, it is useful to explore potential ways to further articulate what it means to be a “good” modeler and to examine how codes of ethics can be more broadly accepted and enforced.

Some of the participants provided useful suggestions for developing and improving codes of ethics. For example, one participant suggested:

It's clear to me that the physical sciences have achieved as best they can because they can quantify things so well. We in the social sciences are not blessed with this ability. So I think our ethics code has to be looser and grander. We can't just say someone has to be able to repeat your experiment and get the same results. The results are so open to bias that the techniques need to reduce that bias. The biases need to be openly discussed.

In this quote, although the participant mentions the social sciences, the content of the quote would seem to apply broadly to computational modeling in general.

Models are inherently open to bias, in the sense that they are designed from specific perspectives, and must necessarily include specific limitations since a model is by definition a simplification of a complex system. Thus, it is indeed a grand challenge to develop relevant codes of ethics. Enforcement was another issue raised by participants. One participant explains:

The first thing people want to cut is quality control, a checklist of ethics. But I personally think it should be enforced. If you don't have a checklist, you're risking a catastrophe. In software, it's hard because they're people who are very independent. But in an ideal world, I think they should be following a list of rules that have ethics in it.

Enforcement of punishments or 'sticks' is thus viewed as an important component of developing an effective code of ethics. However, another participant comments, "How does someone who does really good [in terms of integrity] get rewarded. There is something that's maybe missing there." This participant is thus calling attention to the fact that while unethical behavior is punished with negative reinforcement, highly ethical behavior largely goes unnoticed and unrewarded. So, perhaps in addition to the 'stick' of punishment, there should also be some form of reward or 'carrot' to incentivize ethical behavior.

Finally, perhaps the most compelling quote comes from another participant:

Instead of producing another piece of paper that nobody reads, I think we need a code of ethics that we live. I think leadership teaches this. I think we can start at the bottom, and move its way up, that should be a more effective way to create a code of ethics.

This participant explicitly suggests a bottom-up approach as a way to build buy-in and ensure that a code of ethics is both responsive to the community that it serves and broadly adopted by that same community. Thus, it is fruitful to consider how the process of creating and enforcing codes of ethics could be more bottom-up rather than top-down.

4.2. Survey Results

Participants were asked questions about their experiences with and perspectives on codes of ethics, and also completed the Schwartz Value Survey. This section details the results of comparing the values of individuals with different experiences with and perspectives on codes of ethics.

The first question that participants were asked was: "Are you aware of the code of ethics of any

professional organization?" The complete results of comparison of answers to this question (and others) to the Schwartz Value Survey are provided in Table 1. As illustrated in Figures 1 and 2, nine values had statistically significant results. Individuals who were aware of the code of ethics of a professional organization placed a higher value on influential, respect for tradition, helpful, authority, true friendship, a spiritual life, successful, and preserving my public image. Individuals who were not aware of a code of ethics for a professional society placed a higher value on freedom. While these results indicate correlation, rather than causation, it is interesting to note some common themes, including an emphasis on helping others (helpful, true friendship), obeying social mores (respect for tradition, authority, a spiritual life), and being successful (influential, successful, preserving my public image) on the part of those who were familiar with one or more codes of ethics. Freedom had the opposite result, illustrating that codes of ethics may be perceived in some ways as conflicting with freedom. Overall, awareness of codes of ethics does appear to be correlated with specific basic human values.

The second question was: "Have you ever read the code of ethics of any professional organization?" Here, as illustrated in Figures 3 and 4, the results were very similar to the first question. The results were the same for eight values, including influential, respect for tradition, helpful, authority, true friendship, a spiritual life, successful, preserving my public image, and freedom. Respect for tradition was replaced by devout and equality, both of which were correlated with having read a code of ethics. While devout is consistent with the emphasis on obeying social mores, equality is interesting because it represents a new goal of treating others equally. Thus, familiarity with codes of ethics is also correlated with specific human values.

Finally, the third question was: "Do you feel that computational modelers should follow a code of ethics?" Here, again, ten values were statistically significant, as illustrated in Figures 5 and 6. While for the first two questions, freedom has been correlated with a negative answer, in this case, no values were correlated with a no answer. Instead, all ten values were higher among those who did feel that modelers should follow a code of ethics. Equality, a spiritual life, helpful, and devout were all identified, just as in the previous question. However, social justice, a world at peace, politeness, forgiving, a sense of belonging, and inner harmony were all correlated with a positive response. Thus, it appears that those who believe that modelers should follow a code of ethics not only were more inclined toward justice and equality, but also had better overall piece of mind. Thus, a positive attitude toward a code of ethics also correlated with values.

Table 2. Median Values of Schwartz Value Survey Responses (*= $p < 0.05$; **= $p < 0.01$; *= $p < 0.001$)**

Value	Are you aware of the code of ethics of any professional organization?		Have you ever read the code of ethics of any professional organization?		Do you feel that computational modelers should follow a code of ethics?	
	Yes	No	Yes	No	Yes	No
Equality	6	6	6*	6*	6***	3***
Inner Harmony	6	6	6	6	6*	5.5*
Social Power	2	1	2	1	1	1
Pleasure	3	3	3	3	3	3
Freedom	6*	6*	6*	6*	6	6
A Spiritual Life	5*	3*	5*	3*	4.5**	2.5**
Sense of Belonging	5	4	5	5	5*	3*
Social Order	4	3	4	3	4	3
An Exciting Life	4	4	3	4	4	3
Meaning In Life	6	6	6	6	6	5
Politeness	5	5	5	5	5**	3**
Wealth	3	3	3	3	3	3
National Security	5	6	5	5	5	6
Self-Respect	6	6	6	6	6	6
Reciprocation of Favors	4	3	4	3	3	3
Creativity	6	6	6	6	6	5
A World at Peace	5	4	4	5	5**	2**
Respect for Tradition	3*	2*	3	2	3	2
Mature Love	4	4	5	4	5	3.5
Self-Discipline	5	4	5	4	5	3
Detachment	3	2	3	2	2	0.5
Family Security	6	6	6	6	6	6
Social Recognition	4	3	5	3	4	3.5
Unity with Nature	3	3	3	3	3	2.5
A Varied Life	5	4	4	4	4	4.5
Wisdom	6	5	6	5	6	4

Authority	3*	2*	3*	2*	2	2
True Friendship	6*	5*	6*	5*	5	4.5
A World of Beauty	4	4	4	4	4	3
Social Justice	5	5	4	5	5***	3***
Independent	5	6	5	5	5	6
Moderate	4	3	4	3	4	4
Loyal	6	6	6	5	6	5.5
Ambitious	5	4	5	4	4	4
Broad-Minded	6	5	5	5	6	3.5
Humble	4	4	5	4	4	3
Daring	3	2	3	2	2	3
Protecting the Environment	4	4	4	4	4.5	3
Influential	4**	3**	4*	3*	3	4
Honoring of Parents and Elders	5	5	6	4	5	4
Choosing Own Goals	6	6	5	6	5.5	6
Healthy	6	6	6	6	6	6
Capable	6	6	6	6	6	6
Accepting My Portion in Life	3	3	3	3	3	3
Honest	6	6	6	6	6	6
Preserving My Public Image	3*	3*	4*	3*	3	3
Obedient	5	3	5	3	3	3
Intelligent	6	6	6	6	6	6
Helpful	5*	4*	5*	4*	5*	3*
Enjoying Life	5	5	5	5	5	5
Devout	3	2	5*	2*	3*	0.5*
Responsible	6	5	6	5	5	6
Curious	5	5	5	5	5	5
Forgiving	5	4	5	4	5*	3*
Successful	5*	4*	6**	4**	5	5
Clean	3	3	4	3	3	3

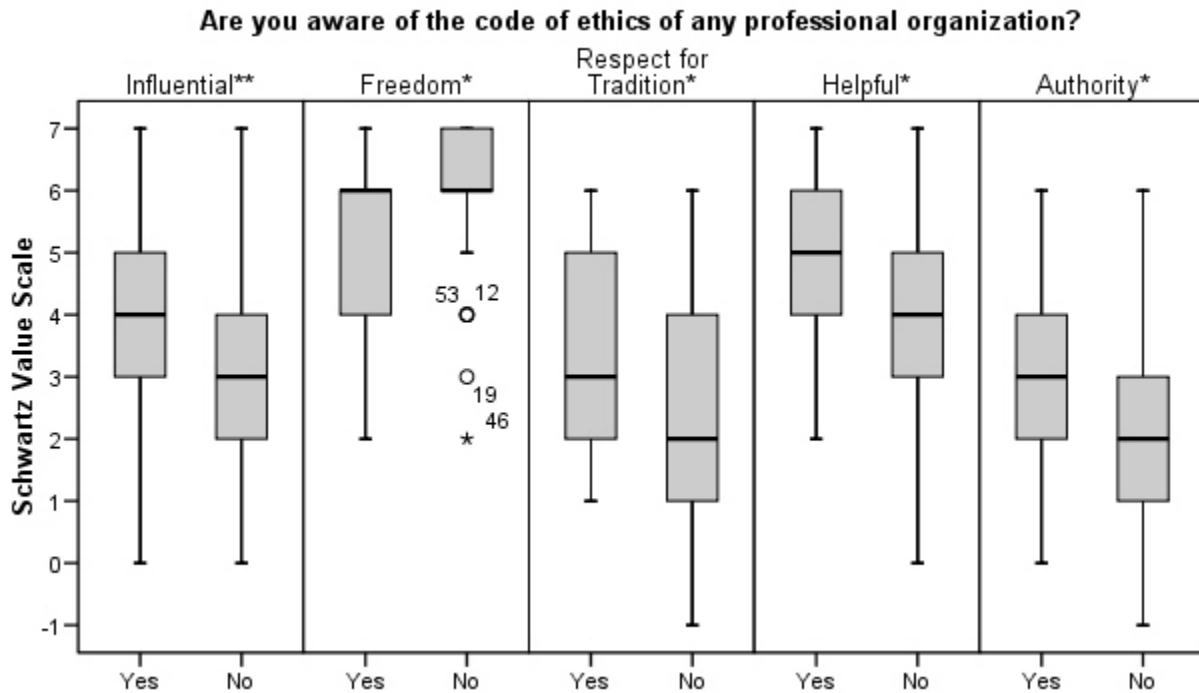


Figure 1. Awareness of Codes of Ethics (*= $p < 0.05$; **= $p < 0.01$)

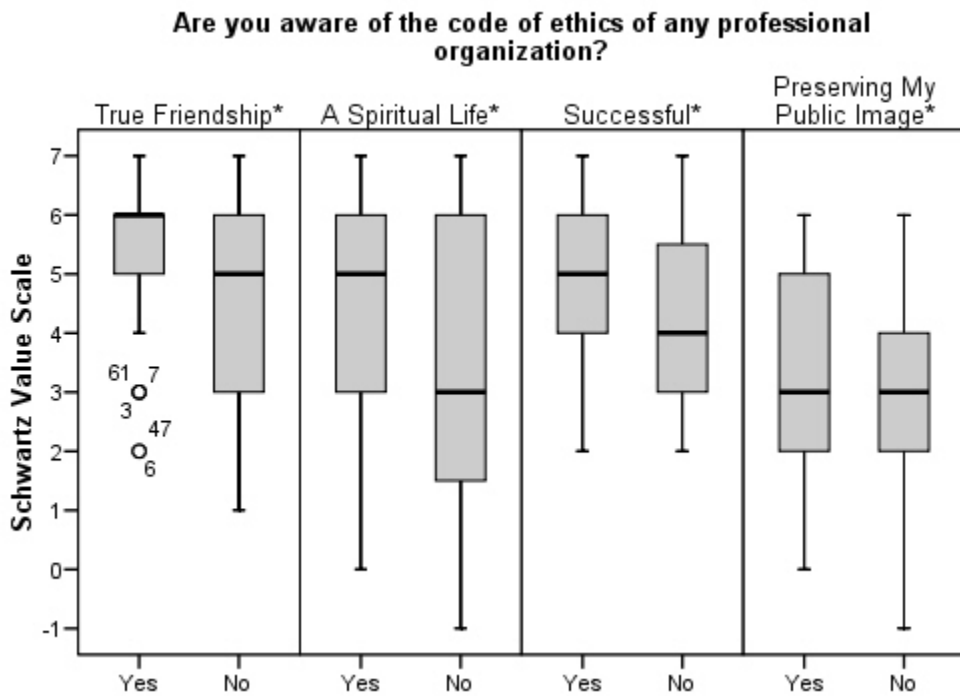


Figure 2. Awareness of Codes of Ethics Continued (*= $p < 0.05$)

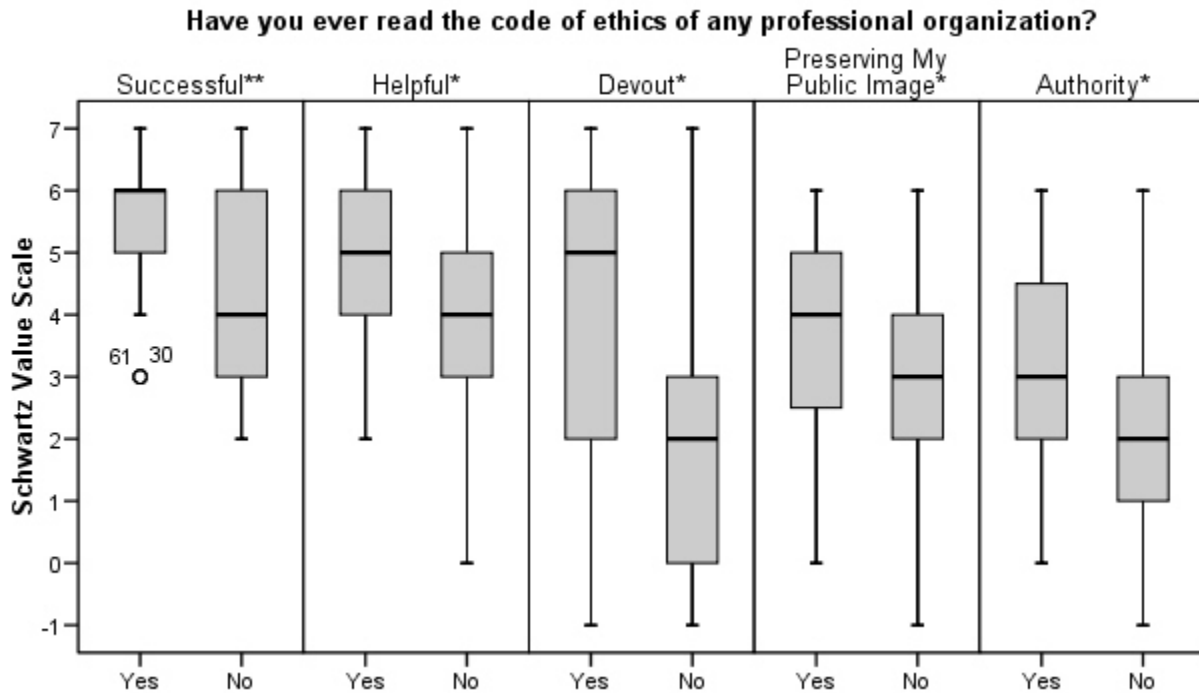


Figure 3. Familiarity with Codes of Ethics (*= $p < 0.05$; **= $p < 0.01$)

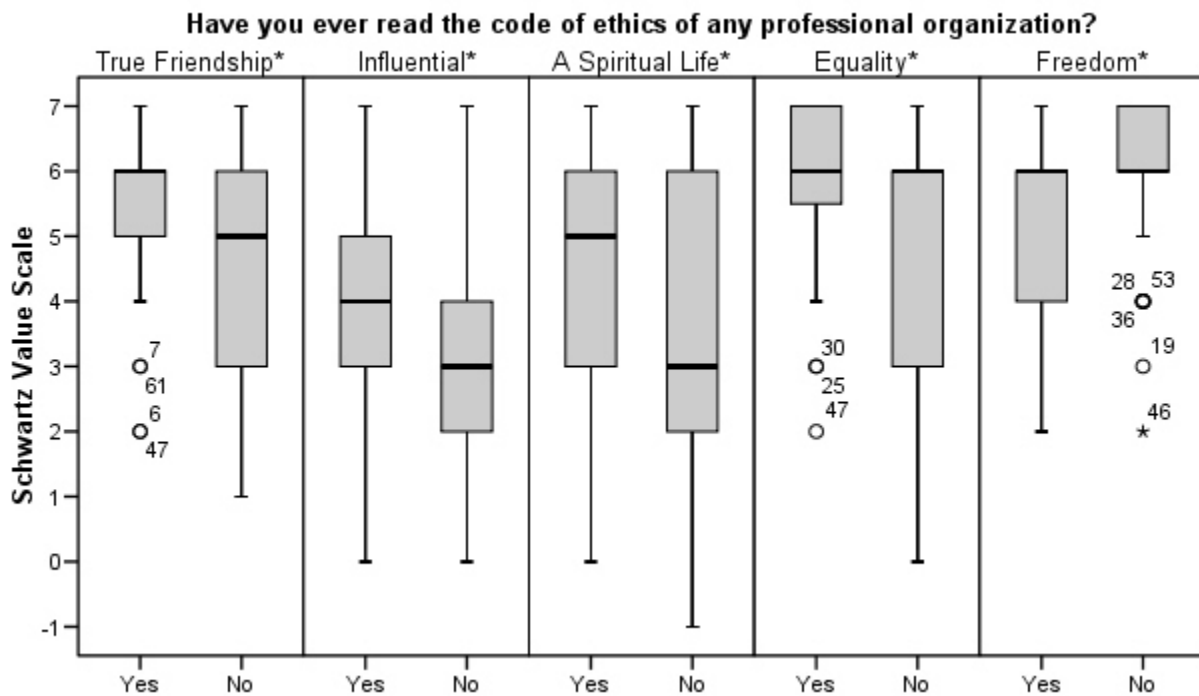


Figure 4. Familiarity with Codes of Ethics Continued (*= $p < 0.05$)

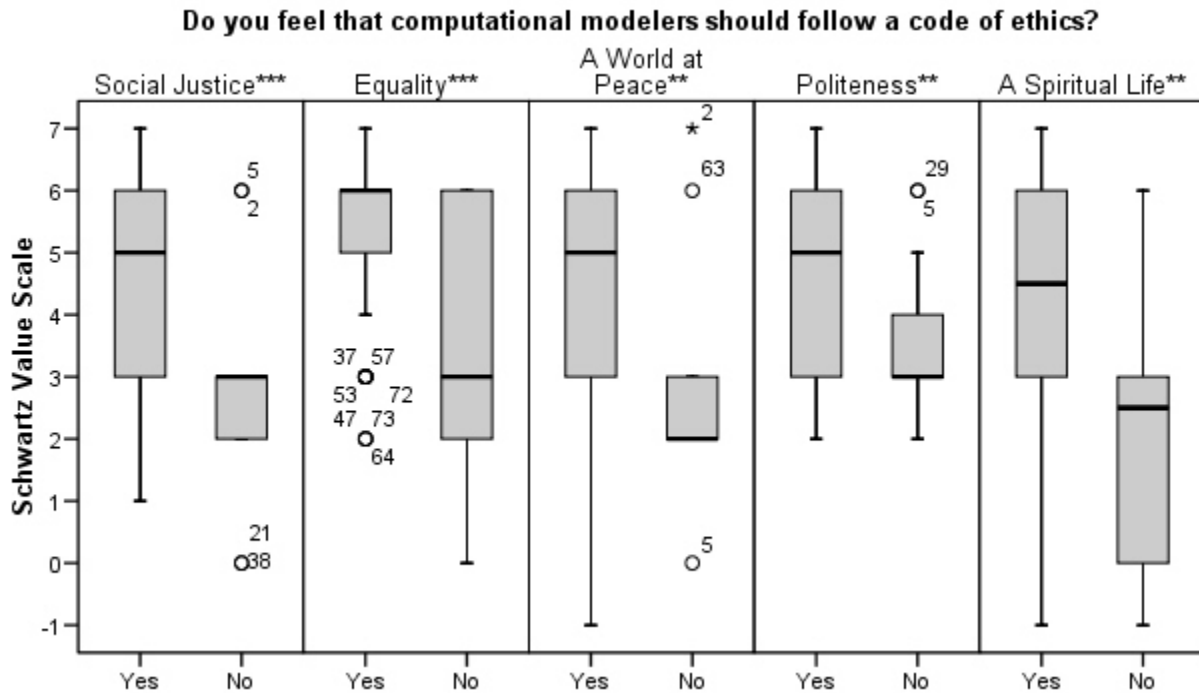


Figure 5. Attitudes toward Codes of Ethics (**=p<0.01; ***=p<0.001)

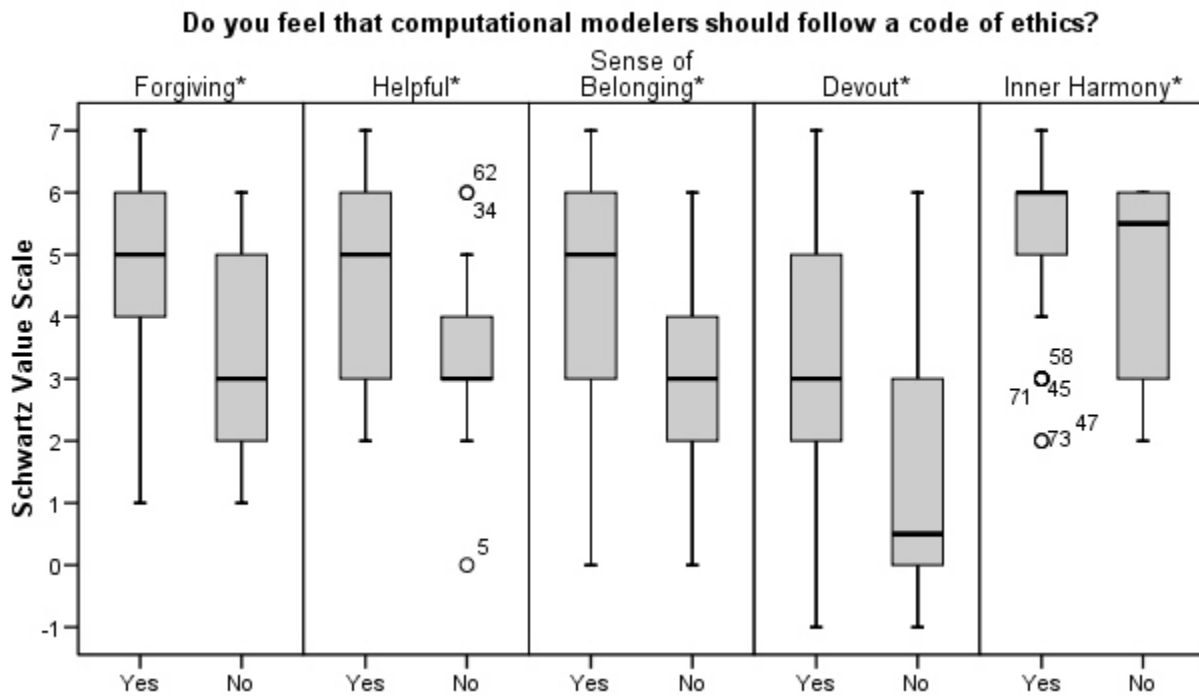


Figure 6. Attitudes toward Codes of Ethics Continued (*=p<0.05)

5. Discussion

This paper focuses on highlighting two key themes that span both the interview and survey data. One of the most interesting interview findings was the belief that modelers should be faithful to the reality and values of users, which matches Mason's covenants with reality and values [12]. Further, to allow users to ensure that these covenants are being followed, it is also necessary for modelers to follow a covenant with transparency [3]. This finding matches the survey data linking belief in the importance of following a code of ethics with values such as helpful, politeness, a spiritual life, devout, inner harmony, a sense of belonging, forgiving, and a world at peace, all of which emphasize the importance of being comfortable with the values of others as well as your own values.

Another interesting finding from the interviews was the emphasis on the development of a bottom-up code of ethics. This idea is consistent with the concept of standardization from below [2], and, among other things, has the potential to incorporate a wide range of stakeholders beyond just modelers themselves and even the direct clients and users of the model [9]. Thus, the notion of a bottom-up code of ethics is an interesting approach for facilitating awareness and compliance with codes of ethics. This finding matches the survey data linking belief in the importance of following a code of ethics with values such as equality and social justice, which emphasize the importance of considering all stakeholders equally and fairly.

6. Conclusion

This paper demonstrates the important connection between values and codes of ethics, finding that several specific basic human values are correlated with awareness of, familiarity with, and attitudes toward codes of ethics. It is important to note that the belief that modelers should follow a code of ethics is positively correlated with ten positive human values. Because computational modeling is such an important part of our everyday lives, yet it is largely beyond the conscious awareness of many of those affected by the models, it is important that computational modelers are aware of, familiar with, and comply with professional codes of ethics.

7. Acknowledgements

This material is based upon work supported by the National Science Foundation under Grant Nos. 0521834, 0646404, 0731717, and 0731718.

8. References

- [1] R.E. Anderson, D.G. Johnson, D. Gotterbarn, and J. Perrolle, "Using the New ACM Code of Ethics in Decision Making", *Communications of the ACM*, 36(2), 1993, 98-107.
- [2] K.R. Fleischmann, "Standardization from Below: Science and Technology Standards and Educational Software", *Educational Technology & Society*, 10(4), 2007, pp. 110-117.
- [3] K.R. Fleischmann and W.A. Wallace, "A Covenant with Transparency: Opening the Black Box of Models", *Communications of the ACM*, 48(5), 2005, pp. 93-97.
- [4] K.R. Fleischmann and W.A. Wallace, "Ensuring Transparency in Computational Modeling", *Communications of the ACM*, 52(3), 2009, pp. 131-134.
- [5] S.I. Gass, "Ethical Concerns and Ethical Answers", In W.A. Wallace (Ed.), *Ethics in Modeling*, Pergamon, New York, 1994, pp. 207-225.
- [6] S.I. Gass, "Ethical Guidelines and Codes in Operations Research", *Omega*, 37, 2008, pp. 1044-1050.
- [7] D. Gotterbarn, "Reconstructing the ACM Code of Ethics and Teaching Computer Ethics", *ACM SIGCSE Bulletin*, 30(4), 1998, pp. 9-11.
- [8] D. Gotterbarn, "How the New Software Engineering Code of Ethics Affects You", *IEEE Software*, 16(6), 1999, pp. 58-64.
- [9] K.H. Judy, "Agile Principles and Ethical Conduct", *Proceedings of the 42nd Hawaii International Conference on System Sciences*, Waikoloa, Hawaii, January 5-8, 2009.
- [10] C.D. Martin, "What Is Computer Ethics?", *ACM SIGCSE Bulletin*, 30(4), 1997, pp. 8-9.
- [11] C.D. Martin and D.H. Martin, "Professional Codes of Conduct and Computer Ethics Education", *Social Science Computer Review*, 8(1), 1990, pp. 96-108.
- [12] R.O. Mason, "Morality and Models", In W.A. Wallace (Ed.), *Ethics in Modeling*, Pergamon, New York, 1994, pp. 183-194.
- [13] S.M. Richardson, K. McNamara Hilmer, and J.F. Courtney, "Compliance with Codes of Ethical Conduct: The Effects of Authority and Proximity on Ethical Reasoning", *Proceedings of the 38th Hawaii International Conference on System Sciences*, Waikoloa, Hawaii, January 3-6, 2005.
- [14] R.S. Rosenberg, "Beyond the Code of Ethics: The Responsibility of Professional Societies", *Computers and Society*, 28(2), 1998, pp. 18-25.
- [15] S.H. Schwartz, "Are There Universal Aspects in the Structure and Contents of Human Values?", *Journal of Social Issues*, 50(4), 1994, pp. 19-45.